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# Biosphere

## 1.1 Biosphere

The biggest scale of ecological organization is the biosphere: the total sum of ecosystems on the planet. Ecological relationships regulate the flux of energy, nutrients, and climate all the way up to the planetary scale. For example, the dynamic history of the planetary atmosphere's CO2 and O2 composition has been affected by the biogenic flux of gases coming from respiration and photosynthesis, with levels fluctuating over time in relation to the ecology and evolution of plants and animals. Ecological theory has also been used to explain self-emergent regulatory phenomena at the planetary scale: for example, the Gaia hypothesis is an example of holism applied in ecological theory. The Gaia hypothesis states that there is an emergent feedback loop generated by the metabolism of living organisms that maintains the core temperature of the Earth and atmospheric conditions within a narrow self-regulating range of tolerance.

The biosphere (from Greek βίος *bíos* "life" and σφαῖρα *sphaira* "sphere") also known as the ecosphere (from Greek οἶκος *oîkos* "environment" and σφαῖρα), is the worldwide sum of all ecosystems. It can also be termed the zone of life on Earth, a closed system (apart from solar and cosmic radiation and heat from the interior of the Earth), and largely self-regulating. By the most general biophysiological definition, the biosphere is the global ecological system integrating all living beings and their relationships, including their interaction with the elements of the lithosphere, geosphere, hydrosphere, and atmosphere. The biosphere is postulated to have evolved, beginning with a process of biopoiesis (life created naturally from non-living matter, such as simple organic compounds) or biogenesis (life created from living matter), at least some 3.5 billion years ago.

In a common sense, biospheres are any closed, self-regulating systems containing ecosystems. This includes artificial biospheres such as Biosphere 2 and BIOS-3, and potentially ones on other planets or moons.

The term "biosphere" was coined by geologist Eduard Suess in 1875, which he defined as the place on Earth's surface where life dwells.

While the concept has a biological origin, it is an indication of the effect of both Charles Darwin and Matthew F. Maury on the Earth sciences. The biosphere's ecological context comes from the 1920s (see Vladimir I. Vernadsky), preceding the 1935 introduction of the term "ecosystem" by Sir Arthur Tansley (see ecology history). Vernadsky defined ecology as the science of the biosphere. It is an interdisciplinary concept for integrating astronomy, geophysics, meteorology, biogeography, evolution, geology, geochemistry, hydrology and, generally speaking, all life and Earth sciences.

The original evidence for life on Earth includes biogenic graphite found in 3.7 billion-year-old metasedimentary rocks from Western Greenlandand microbial mat fossils found in 3.48 billion-year-old sandstone from Western Australia. More recently, in 2015, "remains of biotic life" were found in 4.1 billion-year-old rocks in Western Australia. In 2017, putative fossilized microorganisms (or microfossils) were announced to have been discovered in hydrothermal vent precipitates in the Nuvvuagittuq Belt of Quebec, Canada that were as old as 4.28 billion years, the oldest record of life on earth, suggesting "an almost instantaneous emergence of life" after ocean formation 4.4 billion years ago, and not long after the formation of the Earth 4.54 billion years ago. According to biologist Stephen Blair Hedges, "If life arose relatively quickly on Earth ... then it could be common in the universe.

# 2.Human ecology

## 2.1 Historical development

The roots of ecology as a broader discipline can be traced to the Greeks and a lengthy list of developments in natural history science. Ecology also has notably developed in other cultures. Traditional knowledge, as it is called, includes the human propensity for intuitive knowledge, intelligent relations, understanding, and for passing on information about the natural world and the human experience. The term ecology was coined by Ernst Haeckel in 1866 and defined by direct reference to *the economy of nature*.

Like other contemporary researchers of his time, Haeckel adopted his terminology from Carl Linnaeus where human ecological connections were more evident. In his 1749 publication, *Specimen* academicum de oeconomia naturae, Linnaeus developed a science that included the *economy and polis of nature*. Polis stems from its Greek roots for a political community (originally based on the city-states), sharing its roots with the word police in reference to the promotion of growth and maintenance of good social order in a community. Linnaeus was also the first to write about the close affinity between humans and primates. Linnaeus presented early ideas found in modern aspects to human ecology, including the balance of nature while highlighting the importance of ecological functions (ecosystem services or natural capital in modern terms): "In exchange for performing its function satisfactorily, nature provided a species with the necessaries of life" The work of Linnaeus influenced Charles Darwin and other scientists of his time who used Linnaeus' terminology (i.e., the *economy and polis of nature*) with direct implications on matters of human affairs, ecology, and economics.

## 2.2 The History of human biological

Ecology is not just biological, but a human science as well. An early and influential social scientist in the history of human ecology was Herbert Spencer. Spencer was influenced by and reciprocated his influence onto the works of Charles Darwin. Herbert Spencer coined the phrase "survival of the fittest", he was an early founder of sociology where he developed the idea of society as an organism, and he created an early precedent for the socio-ecological approach that was the subsequent aim and link between sociology and human ecology.

Human ecology is the discipline that inquires into the patterns and process of interaction of humans with their environments. Human values, wealth, life-styles, resource use, and waste, etc. must affect and be affected by the physical and biotic environments along urban-rural gradients. The nature of these interactions is a legitimate ecological research topic and one of increasing importance.

The history of human ecology has strong roots in geography and sociology departments of the late 19th century. In this context a major historical development or landmark that stimulated research into the ecological relations between humans and their urban environments was founded in George Perkins Marsh's book *Man and Nature; or, physical geography as modified by human action*, which was published in 1864. Marsh was interested in the active agency of human-nature interactions (an early precursor to urban ecology or human niche construction) in frequent reference to the *economy of nature.*

# 3. Relation to the environment

## 3.1 Natural environment

The environment of ecosystems includes both physical parameters and biotic attributes. It is dynamically interlinked, and contains resources for organisms at any time throughout their life cycle.Like ecology, the term environment has different conceptual meanings and overlaps with the concept of nature. Environment "includes the physical world, the social world of human relations and the built world of human creation." The physical environment is external to the level of biological organization under investigation, including abiotic factors such as temperature, radiation, light, chemistry, climate and geology. The biotic environment includes genes, cells, organisms, members of the same species (conspecifics) and other species that share a habitat.

The distinction between external and internal environments, however, is an abstraction parsing life and environment into units or facts that are inseparable in reality. There is an interpenetration of cause and effect between the environment and life. The laws of thermodynamics, for example, apply to ecology by means of its physical state. With an understanding of metabolic and thermodynamic principles, a complete accounting of energy and material flow can be traced through an ecosystem. In this way, the environmental and ecological relations are studied through reference to conceptually manageable and isolated material parts. After the effective environmental components are understood through reference to their causes; however, they conceptually link back together as an integrated whole, or *holocoenotic* system as it was once called. This is known as the dialectical approach to ecology. The dialectical approach examines the parts, but integrates the organism and the environment into a dynamic whole (or umwelt). Change in one ecological or environmental factor can concurrently affect the dynamic state of an entire ecosystem.

## 3.2 Disturbance and resilience

Ecosystems are regularly confronted with natural environmental variations and disturbances over time and geographic space. A disturbance is any process that removes biomass from a community, such as a fire, flood, drought, or predation. Disturbances occur over vastly different ranges in terms of magnitudes as well as distances and time periods, and are both the cause and product of natural fluctuations in death rates, species assemblages, and biomass densities within an ecological community. These disturbances create places of renewal where new directions emerge from the patchwork of natural experimentation and opportunity. Ecological resilience is a cornerstone theory in ecosystem management. Biodiversity fuels the resilience of ecosystems acting as a kind of regenerative insurance.

## 3.3 Metabolism and the early atmosphere

Metabolism – the rate at which energy and material resources are taken up from the environment, transformed within an organism, and allocated to maintenance, growth and reproduction – is a fundamental physiological trait.

The Earth was formed approximately 4.5 billion years ago.  As it cooled and a crust and oceans formed, its atmosphere transformed from being dominated by hydrogen to one composed mostly of methane and ammonia. Over the next billion years, the metabolic activity of life transformed the atmosphere into a mixture of carbon dioxide, nitrogen, and water vapor. These gases changed the way that light from the sun hit the Earth's surface and greenhouse effects trapped heat. There were untapped sources of free energy within the mixture of reducing and oxidizing gasses that set the stage for primitive ecosystems to evolve and, in turn, the atmosphere also evolved.

Throughout history, the Earth's atmosphere and biogeochemical cycles have been in a dynamic equilibrium with planetary ecosystems. The history is characterized by periods of significant transformation followed by millions of years of stability. The evolution of the earliest organisms, likely anaerobic methanogen microbes, started the process by converting atmospheric hydrogen into methane (4H2 + CO2 → CH4 + 2H2O). Anoxygenic photosynthesis reduced hydrogen concentrations and increased atmospheric methane, by converting hydrogen sulfide into water or other sulfur compounds (for example, 2H2S + CO2 + h*v* → CH2O + H2O + 2S). Early forms of fermentation also increased levels of atmospheric methane. The transition to an oxygen-dominant atmosphere (the *Great Oxidation*) did not begin until approximately 2.4–2.3 billion years ago, but photosynthetic processes started 0.3 to 1 billion years prior.

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| Complex Table (Less accessible)  **Class Schedule**   |  |  |  |  |  | | --- | --- | --- | --- | --- | | Lesson | Topic | Assignment | Points | DUE | | 1 | What is distance Learning? | WiKi #1 | 10 | March 10 | | Presentation | 20 |  | | 2 | History & Theories | Brief Paper | 20 | March 24 | | Spring Break | | | | | | 3 | Distance Learners | Discussion #1 | 10 | April 7 | | Group Project | 50 | April 14 | | 4 | Media Selection | Blog #1 | 10 | April 21 | |

# lifecycle_apple.gif4. Physical environment

## 4.1 Water

Diffusion of carbon dioxide and oxygen is approximately 10,000 times slower in water than in air. When soils are flooded, they quickly lose oxygen, becoming hypoxic (an environment with O2 concentration below 2 mg/liter) and eventually completely anoxic where anaerobic bacteria thrive among the roots. Water also influences the intensity and spectral composition of light as it reflects off the water surface and submerged particles. Aquatic plants exhibit a wide variety of morphological and physiological adaptations that allow them to survive, compete, and diversify in these environments. For example, their roots and stems contain large air spaces (aerenchyma) that regulate the efficient transportation of gases (for example, CO2 and O2) used in respiration and photosynthesis. Salt water plants (halophytes) have additional specialized adaptations, such as the development of special organs for shedding salt and osmoregulating their internal salt (NaCl) concentrations, to live in estuarine, brackish, or oceanic environments. Anaerobic soil microorganisms in aquatic environments use nitrate, manganese ions, ferric ions, sulfate, carbon dioxide, and some organic compounds; other microorganisms are facultative anaerobes and use oxygen during respiration when the soil becomes drier. The activity of soil microorganisms and the chemistry of the water reduces the oxidation-reduction potentials of the water. Carbon dioxide, for example, is reduced to methane (CH4) by methanogenic bacteria. The physiology of fish is also specially adapted to compensate for environmental salt levels through osmoregulation. Their gills form electrochemical gradients that mediate salt excretion in salt water and uptake in fresh water.

## 4.2 Gravity

The shape and energy of the land is significantly affected by gravitational forces. On a large scale, the distribution of gravitational forces on the earth is uneven and influences the shape and movement of tectonic plates as well as influencing geomorphic processes such as orogeny and erosion. These forces govern many of the geophysical properties and distributions of ecological biomes across the Earth. On the organismal scale, gravitational forces provide directional cues for plant and fungal growth (gravitropism), orientation cues for animal migrations, and influence the biomechanics and size of animals. Ecological traits, such as allocation of biomass in trees during growth are subject to mechanical failure as gravitational forces influence the position and structure of branches and leaves. The cardiovascular systems of animals are functionally adapted to overcome pressure and gravitational forces that change according to the features of organisms (e.g., height, size, shape), their behaviour (e.g., diving, running, flying), and the habitat occupied (e.g., water, hot deserts, cold tundra).

## 4.3 Pressure

Climatic and osmotic pressure places physiological constraints on organisms, especially those that fly and respire at high altitudes, or dive to deep ocean depths. These constraints influence vertical limits of ecosystems in the biosphere, as organisms are physiologically sensitive and adapted to atmospheric and osmotic water pressure differences. For example, oxygen levels decrease with decreasing pressure and are a limiting factor for life at higher altitudes. Water transportation by plants is another important ecophysiological process affected by osmotic pressure gradients. Water pressure in the depths of oceans requires that organisms adapt to these conditions. For example, diving animals such as whales, dolphins, and seals are specially adapted to deal with changes in sound due to water pressure differences. Differences between hagfish species provide another example of adaptation to deep-sea pressure through specialized protein adaptations.

# 5. Biomass

## 5.1 Biomass

Biomass is the mass of living biological organisms in a given area or ecosystem at a given time. Biomass can refer to *species biomass*, which is the mass of one or more species, or to *community biomass*, which is the mass of all species in the community. It can include microorganisms, plants or animals. The mass can be expressed as the average mass per unit area, or as the total mass in the community.

How biomass is measured depends on why it is being measured. Sometimes, the biomass is regarded as the natural mass of organisms *in situ*, just as they are. For example, in a salmon fishery, the salmon biomass might be regarded as the total wet weight the salmon would have if they were taken out of the water. In other contexts, biomass can be measured in terms of the dried organic mass, so perhaps only 30% of the actual weight might count, the rest being water. For other purposes, only biological tissues count, and teeth, bones and shells are excluded. In some applications, biomass is measured as the mass of organically bound carbon (C) that is present.

Apart from bacteria, the total live biomass on Earth is about 560 billion tonnes C, and the total annual primary production of biomass is just over 100 billion tonnes C/yr. The total live biomass of bacteria may be as much as that of plants and animals or may be much less. The total amount of DNA base pairs on Earth, as a possible approximation of global biodiversity, is estimated at 5.0 x 1037, and weighs 50 billion tonnes. In comparison, the total mass of the biosphere has been estimated to be as much as 4 x 10tonnes of carbon.

## 5.2 Terrestrial biomass

Terrestrial biomass generally decreases markedly at each higher trophic level (plants, herbivores, carnivores). Examples of terrestrial producers are grasses, trees and shrubs. These have a much higher biomass than the animals that consume them, such as deer, zebras and insects. The level with the least biomass are the highest predators in the food chain, such as foxes and eagles.

In a temperate grassland, grasses and other plants are the primary producers at the bottom of the pyramid. Then come the primary consumers, such as grasshoppers, voles and bison, followed by the secondary consumers, shrews, hawks and small cats. Finally the tertiary consumers, large cats and wolves. The biomass pyramid decreases markedly at each higher level.

# 6. Η οικογένειά μου